Phase I Project Summary

Firm: Intelligent Automation, Inc.
Contract Number: NNX11CE03P
Project Title: Security-Enhanced Autonomous Network Management for Space Networking

Identification and Significance of Innovation: (Limit 200 words or 2,000 characters whichever is less)

The key innovation in this effort is the development of an industrial-grade analysis testbed to integrate simulation tools, such as ACES, with aviation environmental effects models, such as the Aviation Environmental Design Toolkit (AEDT), to provide a "360-degree" evaluation of new operational concepts. The testbed will be demonstrated by producing such a "360-degree" evaluation of advanced NextGen concepts such as time-based merging and spacing at ATL airport, high-density metroplex concepts, and the efficiency of new route structures with environmentally responsible aircraft using RNAV routing. The industrial-grade software will be implemented in Java and can potentially reduce the analysis time for combined performance/environmental analyses by several months over the current state of the art.

Technical Objectives and Work Plan: (Limit 200 words or 2,000 characters whichever is less)

The overall objective of this work is to extend the ACES$\rightarrow$AEDT tool that was developed under the Phase II proposal and apply it to an additional analysis. The additional analysis involved the performance/environmental differences between time-based and distance-based interval management. While the airspace system is moving towards time-based interval management techniques, there have been no performance/environmental studies of the differences between the current distance-based IM techniques and the newer time-based techniques.

It is important to investigate the performance and environmental impact of these concepts for several reasons. First, many concepts might have a minimal performance impact, but might improve environmental parameters significantly such that its adoption would be very beneficial. Dependent parallel arrivals, time-based merging and spacing, high density flow corridors, 4DTs, and other concepts may have limited impact on performance but large impacts on environmental metrics. The second reason is the opposite: there are some concepts where performance gains are notable, but when viewed through an environmental lens the gains in performance cause problems such that the concept's utility becomes doubtful.

Technical Accomplishments: (Limit 200 words or 2,000 characters whichever is less)

In our Phase I efforts, we implemented the two components of Metrosim, the Metroplex Planner (in Java) and the Airport Planner (as a mixed integer-linear program (MILP)). The Metroplex Planner is responsible for route selection for both arrivals and departures from a Metroplex. The Airport Planner is responsible for runway assignments, wheels on/off times, and surface taxi operations. The Airport Planner accomplishes these goals by using two submodules. The first submodule is the Combined Arrival-Departure Scheduler (CADS), which optimizes the runway throughput by assigning flights to runways and computing wheels on-off times using a MILP formulation. The second submodule optimizes surface operations, including taxi paths and minimizes departure queue holding time, also with an MILP formulation. These components were then tested using recorded data for a busy day at the New York Metroplex (N90), where two airports were configured in Metrosim. The result showed that Metrosim can process the MILP equations in a few minutes, that the Metroplex Planner can also run in a few minutes, and that the final result shows, for the test, an increase in throughput of about 15% compared to the recorded data.

NASA Application(s): (Limit 100 words or 1,000 characters whichever is less)

This tool enables NASA headquarters to make future research investment decisions about advanced aviation concepts using information about both their expected performance impact as well as their expected environmental impact. In addition, analysts at NASA centers that study

advanced concepts (currently, Langley, Ames, and Glenn) can use this tool to fine-tune their ideas so that they meet performance and environmental objectives.

Non-NASA Commercial Application(s): (Limit 200 words or 2,000 characters whichever is less)

Potentially the tool could be used by any airport, FAA analyst, or aviation consultant interested in performing a comprehensive analysis of new concepts under consideration. Thus all congested Metroplex areas (approximately fourteen in the United States), as well as large airlines and all large airports could benefit from using this tool for expansion planning.

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